

RESIN MEMBER AND VEHICLE LIGHTING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a vehicle lighting
5 apparatus having a resin member.

A conventional vehicle lighting apparatus (called as
briefly "vehicle lamp" or "lamp" hereafter) is furnished with
a top-coat layer (protecting film) for protecting an evaporated
layer in a reflecting mirror evaporated with aluminum. It
10 is often practical to color the top-coat layer for coloring
a light reflected on a reflecting mirror (called as "reflector"
hereafter) part when lighting, and emitting, or to color the
light injected into a lighting chamber at daylight, and reflected
on the reflector part. The coloring of the top-coat layer
15 is performed for giving high grade feeling or chromatically
distinguishing the lamp in outside designs.

The lamp furnished with such a colored top-coat layer
is disclosed in the Japanese Application Publication Number:
2001-273804 (JP-A-2001-273804), and is shown in Fig. 10.

20 In this lamp, a resin substrate 501 composing a reflector
5 is formed on its surface with an under-coat layer 502, an
aluminum evaporated layer 503 is formed on the under-coat layer
502, and top-coat layers 505, 506 are formed on the aluminum
evaporated layer 503 by a smoke coating. Of these top-coat
25 layers 505, 506, the top-coat layer 505 having a significant
surface 5x of the reflector 5 is not scattered with a pigment

so as to make less loss of a light emitted from a light source, while the top-coat layers 505, 506 having a non-significant surface 5y is scattered with the pigment so as to color them for chromatically heightening the lamp in an outside design.

5 For manufacturing such a reflector 5, processes as shown in Fig. 11 are necessary.

At first, a forming process S1 is performed where a raw resin material of the reflector 5 is formed into a resin substrate 501 of a desired shape by such as an injection molding.

10 Next, an under-coat layer forming process S2 is carried out to the formed resin substrate 501 on the surface thereof for heightening reflectance of aluminum. Subsequently, the process advances to an aluminum evaporating process S3 where an aluminum is subjected to a resistance heat evaporation to form an aluminum
15 evaporated layer 503 on the under-coat layer 502. Then, the process goes to a smoke coating process S4 where the aluminum evaporated layer 503 is formed thereon with the top-coat layers 505, 506 by the smoke coating, and the reflector 5 is accomplished.

If the top-coat layers 505, 506 are formed on the
20 reflector 5 by the smoke coating in order to improve the outside design of the lamp as disclosed in the above mentioned publication (JP-A-2001-273804), there are problems as follows.

Firstly, it is difficult to make a thickness of the coated film uniform, and there is left uneven outside appearance
25 (as flaring up) being special to the coated face caused by difference in quantity of reflected light owing to irregularity

of the coated film.

Further, in general, irregularity in the color is easy to appear. For example, if a density of a pigment is increased to make the colors deep, the pigment is difficult to disperse and easy to make lumps, so that the colors are easily irregular.

Otherwise, reducing the density of the pigment to make the light colors, the coloring is poor, and if coating the paint several times, the paint runs down to easily cause the color to be irregular.

Since the coated film is wet for a little while after having coated, it absorbs foreign matters and spoils products.

Thus, a yield is limited. Further, bad influences are given to environments by evaporation of a solvent contained in the paint.

SUMMARY OF THE INVENTION

The invention has been accomplished in view of the above mentioned problems, and accordingly it is an object of the invention to chromatically heighten designing quality of a vehicle lamp without coating a paint to the resin member of the lamp.

For solving the above mentioned problems, an invention of a first aspect is characterized by such a resin member, in which a half-mirror evaporated layer is formed by spattering on a resin substrate, while the half-mirror evaporated layer is formed thereon with a reflecting mirror face having an aluminum

evaporated layer as well as a half-mirror face without forming the aluminum evaporated layer.

Since the half-mirror evaporated layer is formed by spattering on the resin substrate, this face is formed uniformly in thickness and color tone, and the color of the resin substrate passes through the half-mirror evaporated layer for making efficient, acquiring a metallic color tone, and effecting outside attractive. Besides, the color tone and shading may be easily adjusted by changing output and time of the spattering, and changing thickness in the evaporated layer. The coating is unnecessary so that cost is reduced and the working process is shortened. By means of the reflecting mirror face having the aluminum evaporated layer, the reflector part is less in loss of quantity of light.

An invention of a second aspect is, in the invention of the first aspect, characterized in that the half-mirror evaporated layer is formed by a chromium spattering.

Since the half-mirror evaporated layer formed by the chromium spattering has good corrosion resistance, protection by the top-coat layer is no longer necessary, so that the cost is reduced and the process is shortened.

An invention of a third aspect is, in the invention of the second aspect, characterized in that reflectance of the half-mirror evaporated layer is determined to be 30 to 65%. According to experiments, in case the reflectance of the half-mirror evaporated layer by the chromium spattering

is determined to be 30 to 65%, the color of the resin substrate and the metallic color tone are well balanced and made especially outside attractive.

5 An invention of a fourth aspect is a vehicle lamp having an extension composed of the resin member as set forth in the first, second or third aspects. Accordingly, the invention of the fourth aspect displays the same performance as the first, second or third aspects, and chromatically heightens the designing quality of the lamp without decreasing the quality
10 of light or coating the paint.

BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a vertically cross sectional view of the lighting apparatus according to the first embodiment of the
15 invention;

Fig. 2 is a front view of the resin member composing the reflector part and the extension of the lighting apparatus;

Fig. 3 is a view for explaining in detail the reflecting mirror part and the extension of the lighting apparatus;

20 Fig. 4A and Fig. 4B are views for explaining the spattering;

Fig. 5 is a view of the process for forming the half-mirror evaporated layer and the aluminum evaporated layer on the resin substrate of the lighting apparatus of to the embodiment;

25 Fig. 6 is a view showing the relation between thickness of the half-mirror face and reflecting mirror face;

Fig. 7 is a view for explaining in detail the reflector part and the extension of the lighting apparatus according to the second embodiment of the invention;

5 Fig. 8 is a view for explaining in detail the reflector part and the extension of the lighting apparatus according to the third embodiment of the invention;

Fig. 9 is a vertically cross sectional view of the lighting apparatus according to the third embodiment;

10 Fig. 10 is a view showing the lighting apparatus furnished with the conventional colored top-coat layer;

Fig. 11 is a view of the process for manufacturing the reflecting mirror face of the conventional lighting apparatus furnished with the top-coat layer.

15 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

In regard to a first embodiment of the invention, explanation will be made in detail, referring to Figs. 1 to 6 of the attached drawings.

20 Fig. 1 is a vertically cross sectional view of the lamp according to the first embodiment of the invention. Fig. 2 is a front view of the resin member composing the reflector part and the extension of the lamp. Fig. 3 is a view for explaining in detail the reflector part and the extension of the lamp.

25 Fig. 4A and Fig. 4B are views for explaining the spattering process. Fig. 5 is a view of the process for forming the half-mirror evaporated layer and the aluminum evaporated layer

on the resin substrate of the lamp of to the embodiment. Fig. 6 is a view showing the relation between thickness of a half-mirror face and a reflecting mirror face.

5 The lamp 100 unifies turn signal lamps 20 and tail stop lamps 22, and is concerned with rear combination lamps equipped at both of left and right sides of a rear part of a vehicle.

The lamp 100 has a container-shaped lamp body 26, a transparently colorless outer cover 28 closing the front face
10 of the lamp body 26, and a lamp chamber 29 sectioned with the lamp body 26 and the outer cover 28. The lamp chamber 29 is arranged at the interior with parabolic reflectors 20a, 22a in the turn signal lamps 20 as well as the tail stop lamps 22, and the resin substrate 10 formed with the extension 24
15 integrally extending from the circumference of the reflectors 20a, 22a. The extension 24 closes an opening created in the circumference of the reflectors 20a, 22a for sealing the interior of the lamp 100 through the opening so as to make the lamp 100 attractive.

20 At a focal position of the reflector part 20a of the turn signal lamps 20, a light source 20b composed of a bulb in umber color is placed. The light source 20b is bayonet-connected at its rear part to the lamp body 26 through an aperture 20h at a rear end of the reflector 20a. Also at
25 a focal position of the reflector part 22a of the tail stop lamps 22, a light source 22b composed of a red bulb is placed.

The light source 22b is bayonet-connected at its rear part to the lamp body 26 through an aperture 22h at a rear end of the reflector 22a. The light source 22b is protected with a cover 22c which is evaporated at a front end 22d with aluminum
5 so that the light source 22b is not seen by the front end 22d of the cover 22c when looking at the lamp 100 from the front side.

At a front side of the light source 22b of the tail stop lamps 22, a transparently colorless inner lens 22i is
10 arranged which is furnished with a diffusion step on a rear face for giving the tail stop lamps 22 a desired distribution of light.

The resin substrate 10 is formed by injection molding of black polycarbonate (PC). Other than this, there available
15 various resins such as acrylonitrile/ethylene-propylene-diene/styrene resin (AES), acrylonitrile/styrene/acrylate resin (ASA), acrylonitrile/butadiene/ styrene resin (ABS), or polypropylene (PP). The resins other than PC probably demands the under-coat layer when chromium spattering. Of course,
20 optional colors can be selected in response to designing requirements.

On the whole of the front face of the resin substrate 10, as shown at an enlarged A part in Fig. 3, chromium is evaporated by spattering and the half-mirror evaporated layer 30 of less
25 than 20 nm is formed. Further, on the front faces of the reflector parts 20a, 22a, as shown at an enlarged B part in

the same, aluminum is evaporated and the aluminum evaporated layer 40 of 100 to 150 nm is formed. The aluminum evaporated layer 40 is the reflecting mirror face 42 reflecting almost all of the injected light, and is formed thereon with a further
5 protective film 50 such as polymerized film of organic silicone.

The front face of the extension 24 is, as shown at the enlarged A part, the chromium half-mirror evaporated layer 30 remains as exposed. The half-mirror evaporated layer 30 is a half-mirror face which reflects about half of the injected
10 light and passes about half of the injected light. Therefore, in the half-mirror face 32 exposing the half-mirror evaporated layer 30, the color of the resin substrate 10 transmits the half-mirror evaporated layer 30, and the reflected light of a metallic color tone is present, and so while making the color
15 of the resin substrate 10 efficient, the metallic color tone having hard image is obtained.

On the basis of Fig. 4A, explanation will be made to a method of evaporating the chromium on the resin substrate 10 by sputtering. Within a vessel 6 supporting Ar gas atmosphere
20 of low pressure, there are placed a cathode 7 fixing a chromium target 8 to be evaporated and an anode 9 fixing the resin substrate 10, and voltage is supplied between the cathode 7 and the anode 9 to cause discharge. Then, the Ar gas is ionized and Ar ions 11 collide against the chromium target 8 on the cathode 7,
25 and chromium atoms 5 leap out from the chromium target 8 by the collision, and when the chromium atoms 5 leap on the surface

of the resin substrate 10, the chromium is evaporated on the resin substrate 10.

In the sputtering, since the chromium atoms uniformly leap out from the whole of the surface of the sheet-like chromium target 8 having a broad area, the chromium can be evaporated on the surface of the resin substrate 10 in a uniform thickness 14 of high purity as shown in Fig. 4B.

On the basis of processes shown in Fig. 5, explanation will be made to a method of forming the half-mirror evaporated layer and the aluminum evaporated layer on the resin substrate.

At first, in a forming process S11, a raw resin material (polycarbonate) is formed by an injection molding so as to manufacture the resin substrate 10 having the reflector parts 20a, 22a and the extension 24.

Next, the process advances to a chromium sputtering process S12 in which the chromium is evaporated by sputtering on the whole of the front face of the resin substrate 10, and the half-mirror evaporated layer 30 is formed. A pre-treatment such as forming the under-coat layer or de-humidification drying having been necessary to the aluminum evaporation is not required before the chromium sputtering process S12. But, depending on the resin substrate 10 (for example, polypropylene resin), the under-coat layer forming process might be necessary.

Subsequently, the process goes to the aluminum evaporating process S13 in which the mask is formed on the extension 24 and the aluminum is evaporated as conventionally

on the half-mirror evaporated layer 30 before the resin substrate 10. Thus, on the only reflector parts 20a, 22a, the reflecting mirror faces 20e, 22e comprising the aluminum evaporated layer 40 is formed. Herein, the half-mirror evaporated layer 30 becomes the under-coat layer of the aluminum evaporated layer 40.

The process advances to the protecting film forming process S14. While the mask is held on the extension 24, the protective film 50 such as a polymerized film of an organic silicone is formed on the aluminum evaporated layer 40 by a plasma polymerization, so that the resin member is manufactured.

Incidentally, in general, the longer is the sputtering time, the larger is the thickness of the half-mirror evaporated layer 30. In addition, the larger is the output supplied when sputtering, the larger is the film thickness of the half-mirror evaporated layer 30. If adjusting the sputtering output and time, the thickness of the half-mirror evaporated layer 30 can be arbitrarily adjusted. As to the thickness and the reflectance of the half-mirror evaporated layer 30, as shown in Fig. 6, the reflectance becomes higher together with the thickness until the thickness is 15 nm, and it reaches a top when the reflectance is 65%, and by adjusting the sputtering output and time, the thickness of the half-mirror evaporated layer 30 can be arbitrarily adjusted.

According to experiments, while the color of the resin substrate 10 is made efficient, the metallic color tone of

hard image is obtained, and when the reflectance of the half-mirror evaporated layer 30 is 30 to 65%, many people feel it most attractive, and at this time, the thickness of the half-mirror evaporated layer 30 is around 5 to 15 nm.

5 Since the embodiment is composed as mentioned above, effects are displayed as follows.

 In the lamp 100, since the chromium half-mirror evaporated layer 30 is formed on the resin substrate 10 composing the extension 24, the half-mirror evaporated layer 30 can effect
10 the color tone while making the color of the resin substrate efficient, and the metallic color tone of hard image is obtained.

 Besides, since the chromium has good adhesion and corrosion resistance, the pre-treatment as forming the under-coat layer is unnecessary before the spattering, and cost can be cut down
15 and the working processes can be shortened.

 Since the half-mirror evaporated layer 30 is formed by spattering, it can be formed to be uniform in thickness and made attractive. Moreover, since the thickness of the half-mirror evaporated layer 30 can be changed by changing
20 the spattering output and time, the color tone and shading can be easily adjusted.

 Since the painting is not carried out, it is not practiced as conventional examples that the coated film absorbs foreign matters and spoils products, and the yield is increased. Further,
25 bad influences are not given to environments by evaporation of a solvent contained in the paint.

Next, a second embodiment will be explained on the basis of Fig. 7 showing the extension and the reflector part in detail.

In the first embodiment, the aluminum evaporated layer 40 is formed on the chromium half-mirror evaporated layer 30 in the reflector parts 20a, 22a. However in this embodiment, in the reflector parts 20a, 22a, the under-coat layer 44 is formed on the resin substrate 10 as shown at the enlarged view of B, and the aluminum evaporated layer 40 is formed on the under-coat layer 44, and the protective film 50 is formed on the aluminum evaporated layer 40. Others are the same as those of the first embodiment in general.

For forming the reflector parts 20a, 22a, the masks are placed only before the reflector parts 20a, 22a, while the resin substrate 10 is performed with the chromium sputtering, and then, the mask is placed before the extension 24, and the aluminum evaporation is performed to the resin substrate 10 as the conventional manner. This embodiment displays the same effect as the first embodiment.

Now, a third embodiment will be explained on the basis of Fig. 8 showing the extension and the reflector part in detail.

In the first and second embodiments, the aluminum evaporated layer 40 is formed in the reflector parts 20a, 22a.

However in this embodiment, the chromium is evaporated by sputtering all over the front face of the resin substrate 10, and as shown at the enlarged view of A, the half-mirror evaporated

layer 30 is formed all over the resin substrate 10. Then, the mask is placed to the extension 24, and the chromium spattering is again carried out. The reflecting mirror faces 36 are formed such that the chromium evaporated layer 34 of the reflector parts 20a, 22a are made thicker than the half-mirror evaporated layer 30. Others are the same as those of the first embodiment in general.

Although the chromium evaporated layer 34 of this embodiment is inferior in the reflectance to the aluminum evaporated layer, a necessary reflectance as the reflector of a sign post can be secured. The embodiment displays the same effects as the first embodiment, and besides, since the chromium half-mirror evaporated layer 30 and the chromium evaporated layer 34 do not demand the protective film, cost can be cut down and the working processes can be shortened.

On the basis of Fig. 9, a fourth embodiment will be explained. This embodiment is concerned with a head lamp 60 in which the half-mirror evaporated layer 30 is formed by evaporating the chromium on the front faces of the extension 62. A color of the extension is preferably a color near to silver of the reflector 64. Others are the same as the above mentioned head lamps in general. Since the reflector 64 of the head lamp has a high temperature, the extension 62 is independent of the reflector 64. This embodiment also exhibits the same effects as the first embodiment.

Incidentally, the invention is not limited to the above

mentioned embodiments, and various deformations are available.

For instance, in the first embodiment, the front faces of the reflector parts 20a, 22a are all the reflecting mirror faces 42, but as to the non-significant face not reflecting the light emitted from the light source s 20b, 22b in a parallel direction with an optical axis, it is sufficient that the aluminum evaporated layer is not formed but the chromium half-mirror evaporated layer 30 is exposed as the half-mirror face 32. In this case, since colored parts are increased, the designing quality may be more heightened.

Further, in the above respective embodiments, the chromium half-mirror evaporated layer 30 is formed on the resin substrate 10, but metals other than the chromium, for instance, aluminum, titanium or appropriate alloys may be evaporated. Of course, the invention can be applied to general vehicle lamps.

As apparently from the above explanation, according to the invention of the first aspect, since the half-mirror evaporated layer is formed by spattering on the light impermeable resin substrate, the half-mirror evaporated layer is made uniform in thickness and color tone, and besides, the metallic color tone is obtained as making the color of the resin substrate efficient and more attractive than that of the smoke coating, so that the designing property is heightened. Moreover, the color tone and shading can be easily adjusted by changing the spattering output and time so as to change the thickness of

the evaporated layer. Since the painting is not carried out, it is not practiced that the coated film absorbs foreign matters and spoils products, and the yield is increased. Further, bad influences are not given to environments by evaporation of a solvent contained in the paint. By the reflecting mirror face formed with the aluminum evaporated layer on the half-mirror evaporated layer, the light can be reflected without causing loss of light.

In the invention of the second aspect, since the half-mirror evaporated layer is formed by the chromium sputtering process, the top-coat layer is no longer necessary, because the chromium has the good corrosion resistance, so that the cost is reduced and the working process is shortened.

In the invention of the third aspect, since the reflectance of the half-mirror evaporated layer is determined to be 30 to 65%, the color of the resin substrate and the metallic color tone are well balanced and made especially outside attractive.

The invention of the fourth aspect is the vehicle lamp having the extension composed of the resin member as set forth in the first, second or third aspects. Accordingly, the same performance are displayed as the first, second or third aspects, and chromatically heightens the designing quality of the lamp without decreasing the quality of light or coating the paint.